Achieving high quality standards in laparoscopic colon resection for cancer : A Delphi consensus-based position paper

MISiCOL Task Force

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Achieving high quality standards in laparoscopic colon resection for cancer: A Delphi consensus-based position paper

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ABSTRACT

Aim: To investigate the rate of laparoscopic colectomies for colon cancer using registries and population-based studies. To provide a position paper on mini-invasive (MIS) colon cancer surgery based on the opinion of experts leader in this field.
Methods: A systematic review of the literature was conducted using PRISMA guidelines for the rate of laparoscopy in colon cancer. Moreover, Delphi methodology was used to reach consensus among 35 international experts in four study rounds. Consensus was defined as an agreement ≥75.0%. Domains of interest included nosology, essential technical/oncological requirements, outcomes and MIS training.
Results: Forty-four studies from 42 articles were reviewed. Although it is still sub-optimal, the rate of MIS for colon cancer increased over the years and it is currently >50% in Korea, Netherlands, UK and Australia. The remaining European countries are un-investigated and presented lower rates with highest variations, ranging 7–35%. Using Delphi methodology, a laparoscopic colectomy was defined as a "colon resection performed using key-hole surgery independently from the type of anastomosis". The panel defined also the oncological requirements recognized essential for the procedure and agreed that when performed by experienced surgeons, it should be marked as best practice in guidelines, given the principles of oncologic surgery be respected (R0 procedure, vessel ligation and mesocolon integrity).
Conclusion: The rate of MIS colectomies for cancer in Europe should be further investigated. A panel of leaders in this field defined laparoscopic colectomy as a best practice procedure when performed by an experienced surgeon respecting the standards of surgical oncology.

Introduction

Colorectal cancer (CRC) is the second most frequent diagnosed cancer with an incidence of about 450.000 new cases in Europe and 100.000 new patients/year in the US [1,2].

Currently, upfront surgical resection remains the standard of care for non-metastatic tumors. Over the last three decades several progresses were made for improving treatment, the survivals and quality of life of cancer patients; the main innovation being the outbreak of laparoscopic procedures in 1991 [3,4].

Initial concerns, including those related to a long training, the development of port-site metastasis, the sustainability or the adherence to surgical oncology principles [5–9], were subsequently surmounted and in recent years a number of studies recognized the short-term functional benefits and the equivalent long-term oncological results of this approach. In accordance with these evidences, few national health authorities recommended the use of mini-invasive surgery (MIS) as the preferred option for suitable patients [9].

Surprisingly, despite these evidences and efforts, a number of population-based studies report low rates of MIS colectomies in European countries and in the UK [9,10].

The European Society of Surgical Oncology, ESSO, aims to develop standards for cancer patients through its core values, as well as its education activities, in homogenization of skills, quality healthcare and ultimately qualification.

In line with such mission, a core group of ESSO members aimed this study to investigate the actual rate of MIS for colon cancer in different continents and to provide position statements in the form of a "White Paper" (a report provided by authoritative experts that informs readers concisely about a this issue) on laparoscopic colectomy. As a matter of fact, this manuscript was designed to outline the adoption of laparoscopic colectomy for cancer globally, but also to provide an authoritative report based on experts consensus supporting a common definition of MIS colectomy (what is and what is not), its technical requirements, the oncological items that should be assured and the path of training to achieve a gold standard. Experts were interviewed using a modified Delphi technique. Named after the Oracle at Delphi, this approach is an internationally validated group facilitation that searches for a consensus through a series of interview rounds and allows the collection of experts' opinions [11]. Accordingly, and on the basis of an ESSO initiative, experts were selected mainly, but not exclusively in the Eurozone.

Methods

PRISMA data source and search strategies

This investigation has been conducted adhering to the PRISMA Statement for review and meta-analysis (Fig. 1). We conducted a systematic review of the literature by searching PubMed database using the following search strategy: "colonic neoplasms" [MeSH Terms] AND "registries" [MeSH Terms] AND ("surgical procedures, operative" [MeSH Terms] OR "general surgery" [MeSH Terms]) NOT "robotic surgical proceduresv" [MeSH Terms] AND "europe" [MeSH Terms] AND ("humans" [MeSH Terms] AND English [lang]); "laparoscopy/epidemiology" [MeSH Major Topic] AND "colonic neoplasms" [MeSH Terms] NOT "robotic surgical procedures" [MeSH Terms] AND ("humans" [MeSH Terms] AND English [lang]); "laparoscopy/statistics and numerical data" [MeSH] AND "colonic neoplasms" [MeSH Terms] NOT "robotic surgical procedures" [MeSH Terms] AND ("2007/05/08" [PDAT]: "2017/05/04" [PDAT]) AND ("humans" [MeSH Terms] AND English [lang]); "laparoscopy/trends" [MeSH] AND "colonic neoplasms" [MeSH Terms] NOT "robotic surgical procedures" [MeSH Terms] AND ("humans" [MeSH Terms] AND English [lang]) and "laparoscopy/utilization" [MeSH] AND "colonic neoplasms" [MeSH Terms] NOT "robotic surgical procedures" [MeSH Terms] AND ("humans" [MeSH Terms] AND English [lang]).

If studies missed data from any European countries, a further search for "laparoscopic colectomy rate in …" was repeated in PubMed including the members European union as listed in https://europa.eu/european-union/about-eu/countries en.

Significant references from retrieved publications were also included. Duplicate references were removed by manual search. Authors of this study were blinded to authors' and journals' name while reviewing the series, and did not have any contacts with the authors of the included papers. We did not consider any journal's scores (e.g., journal's Impact Factors) of the published series as exclusion criteria for this review.

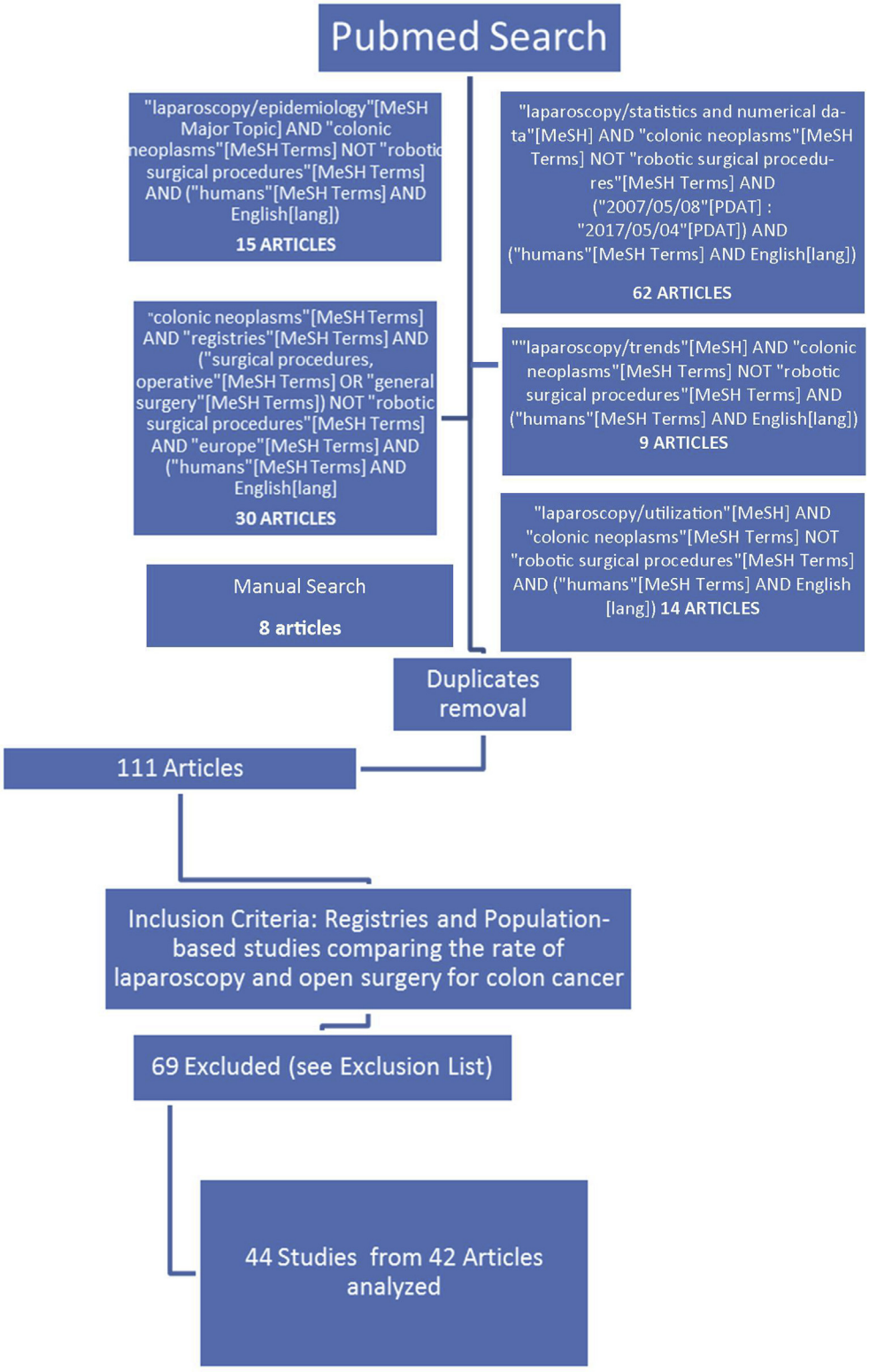

Fig. 1. PRISMA flow chart for systematic review investigating the burden of mini-invasive surgery.

The systematic review was aimed to detect the rate of MIS surgery for colon cancer independently from the time of investigation, definition of the procedure, conversion surgery or country. Furthermore, we focused our analysis on registries, population-based/multi-institutional studies. Accordingly, manuscripts providing exclusively open or laparoscopic series, case-control/case-matched studies and RCTs were excluded (Supplement File 1, Exclusion List). For the purpose of this study, each article was assessed by evaluation of the title and the abstract; if the latter was uninformative, the full paper was reviewed.

Moreover, a systematic review of the principal national and international surgical societies guidelines published on PubMed or

available in Internet using standard search engines (i.e. Google, keywords: "laparoscopy", "colon cancer" and "scientific society" and "Guidelines") has been conducted aiming to detect societies' recommendations (limit to English language).

PRISMA outcome measures

Main outcome measure of the systematic review was the rate of MIS. Whenever possible we focused on colon cancers (thus excluding rectal cancer); also, emergency resections were outlined as well as time-period range or geographic variations.

Delphi study design

On March 2016, ESSO board members approved the study and appointed a coordinator (DD). The coordinator designed a MIS task force who was in charge of literature review, questionnaires development and data analysis (LL, AB, RDL). Study begun on April 2016 when the task force selected the topics for the Delphi study through a bibliographic search (full details in Supplement File 2). Topics were selected on the basis of the "White Paper" parts, thus they should encompass definition, a discussion of relevant issues for targeted readers (surgical oncologists), contain technical details and quote significant references. One author (LL) collected literature data, while two others evaluated the papers independently (AB and RDL). Literature review focused on 2 main topic areas to structure the questionnaires (nosology: laparoscopy definition, anastomoses, extraction site, best practice/guidelines, essential technical/oncological items, and outcome: right colon cancer, left colon cancer, short term and long term outcomes, use of adjuvant therapy and ERAS protocols). A further "domain" (training) was integrated in Round 2 on the basis of experts' preferences selection.

Panel of experts

A panel of experts was selected by the ESSO board, supported by ETC committee members and included leading surgeons in MIS colectomy with an outstanding clinical background and scientific track record from different European and extra-European countries (Mini-Invasive Surgery Collaborators –MISiCOL- Task Force). Although there are no clear guidelines regarding the minimum number of panelists to be included, for the purpose of this investigation a panel size of more than 30 experts was considered as appropriate. Panel composition (see Collaborators List) was designed in accordance with international recommendations [12]. Invitation were mailed to possible participants by ESSO chief operating officer and study coordinator, along with a brief explanation of the study goals, the bibliographic search that driven the investigation, the definition of the consensus and the domain of interest (see supplementary materials).

Questionnaires and rounds

According to the Delphi methodology an un-defined number of rounds should be performed, until a consensus is reached; MIS task force designed this study according to a modified Delphi technique consisting in 3 rounds of self-administered questionnaire and a final meeting held in Berlin on September 2017 for the final presentation of the consensus statements [13]. Questionnaires were emailed to participants in all rounds. Reminders were sent to non-responders on a regular basis with a maximum of three reminders/person. Questionnaires were designed with different type of answers (yes or no, check-off or open), including also Likert scales (ranging from 1: complete disagreement to 7: complete agreement), implemented by marking red the "dis-agreement area" and green the "agreement area" of choice and specifying the "neutral" choice (n 4). Full questionnaires - as they were administered to the experts-are available in Supplement File 3. Questionnaire in Round 1 consisted of 5 parts: Part A aimed to demographics, volume of MIS and training, Part B focused on definitions, Part C on the clinical and technical aspects of laparoscopic resection for colon cancer, Part D on laparoscopic resection for colon cancer in clinical practice and finally Part E on personal considerations and Delphi rating. Subsequent rounds were introduced by a brief paragraph for iteration of results and included remarks and suggestions from the previous rounds; of note, questions where consensus was reached during the first round were omitted. ESSO chief operating officer was in charge of emailing questionnaires during the first 2 rounds in order to respect the anonymity of the panel. Questionnaire in Round 2 consisted of 5 parts: Part B focused on definitions, Part C on the clinical and technical aspects of laparoscopic resection for colon cancer, Part D on laparoscopic resection for colon cancer in clinical practice, Part E on training and Part F on personal considerations and Delphi rating. Round 1 ended on May 2017, data were analyzed and following a second questionnaire was developed on June 2017. Round 2 ended on July 2017 and a subsequent brief Round 3 consisting exclusively in 5 questions was emailed on August 2017. As previously stated, all members of the panel were invited to a face-to-face meeting during the ESCP Congress; however, six attended and other two joined via Skype connection, the remaining received iteration by email correspondence. During this brief consultation all statements produced so far were reviewed and extensively discussed between panel members, and it was agreed to implement the study with a concise Round 4 consisting in seven questions. Study ended on October 2017.

Consensus

Consensus for single/multiple choice questions was defined as an agreement equal or greater than 75% between respondents (number of identical answers divided by the number of respondents), whereas for Likert scale, it was defined as an agreement equal or greater than 75% for values ranging 6–7; on the other hand dis-agreement was defined as equal or greater than 75% for values 1–2 on the scale (75% of the ratings being in the lowest or highest tertile [13]).

Statistical methods

For the purpose of data collection and analysis a Database for PRISMA systematic review and another Database for Delphi investigation were constituted. Data from the four rounds were reported and analyzed separately. Continuous variables were analyzed using means and standard deviations and compared using the T Test, whereas categorical variables were analyzed using frequencies and percents. For each consensus statement we reported the consensus rate, and for Likert scales it included the mean, mode and median values, the coefficient of variation (CV) and the interquartile range (IQR). Databases and statistical analyses were obtained using Excel (Microsoft Corporation, USA), MedCalc (MariaKerke, Belgium) and SPSS (IBM, Armonk USA) software. All tests were performed two-tailed and a p value < 0.05 was considered as statistically significant.

Results

The Adoption of MIS for colon cancer: a systematic review

Table 1 shows the 42 articles included in the systematic review [9,10,14–53]. Forty-four studies reviewed included 3.945.263 colorectal cancer patients, with a mean number of 89665.1/study

Table 1
Literature reporting the burden of laparoscopy for colon cancer: results from registries and population based studies.

N	Author	Title	Journal	Country	Setting	N of Patients	Rate of Laparoscopic Patients	Years of Investigation	Ref
1	Aslani N, Lobo-Prabhu K, Heidary B et al.	Outcomes of laparoscopic colon cancer surgery in a population-based cohort in British Columbia: are they as good as the clinical trials?	Am J Surg 2012;204:411–5.	Canada	Elective + Emergency	2013	15.0 Range TP: 2–25 Emergency 0.74	2003–2008	[14]
2	Sippey M, Spaniolas K, Manwaring ML et al.	Surgical resident involvement differentially affects patient outcomes in laparoscopic and open colectomy for malignancy.	Am J Surg 2016;211:1026–34.	USA	Elective	26190	37.4	2005–2012	[15]
3	Khalid U, Evans MD, Williams GL et al.	Variability in management of T1 colorectal cancer in Wales.	Ann R Coll Surg Engl 2013;95:477–80.	UK (Wales)		95 (T1 cancers)	51.0	2009–2011	[16]
4	Rea JD, Cone MM, Diggs BS et al.	Utilization of laparoscopic colectomy in the United States before and after the clinical outcomes of surgical therapy study group trial.	Ann Surg 2011;254:281–8.	USA	Elective	741817	7.6 Range TP: 2.3–8.9	2001–2007	[17]
5	Simorov A, Shaligram A, Shostrom V et al.	Laparoscopic colon resection trends in utilization and rate of conversion to open procedure: a national database review of academic medical centers	Ann Surg 2012;256:463	USA		85712	42.2 Range TP: 37.5–44.1	2008–2011	[18]
6	Krarup PM, Nordholm-Carstensen A, Jorgensen LN et al.	Anastomotic leak increases distant recurrence and long-term mortality after curative resection for colonic cancer: a nationwide cohort study.	Ann Surg 2014;259:930–8.	Netherlands	Elective + Emergency	9333	16.7	2001–2008	[19]
7	Bilimoria KY, Bentrem DJ, Nelson H et al.	Use and outcomes of laparoscopic-assisted colectomy for cancer in the United States.	Arch Surg 2008;143:832–9.	USA		242419	4.5 Range TP: 3.8–5.2	1998–2002	[20]
8	Cone MM, Herzig DO, Diggs BS et al.	Dramatic decreases in mortality from laparoscopic colon resections based on data from the Nationwide Inpatient Sample.	Arch Surg 2011;146:594–9.	USA	Elective + Emergency	1314696	6.8	2002–2007	[21]
9	Kang CY, Halabi WJ, Luo R et al.	Laparoscopic colorectal surgery: a better look into the latest trends.	Arch Surg 2012;147:724–31.	USA		244098	27.6 Range TP: 13.8–42.6	2007; 2009	[22]
10	Dik VK, Aarts MJ, Van Grevenstein WM et al.	Association between socioeconomic status, surgical treatment and mortality in patients with colorectal cancer.	Br J Surg 2014;101:1173–82.	Netherlands	Elective + Emergency	4422	25.8	2005–2010	[23]
11	Faiz O, Haji A, Bottle A et al.	Elective colonic surgery for cancer in the elderly: an investigation into postoperative mortality in English NHS hospitals between 1996 and 2007.	Colorectal Dis 2011;13:779–85.	UK	Elective	28746	3.0 (pts > 75 yrs) Range TP: 0.4–11.8	1996–2007	[24]
12	Chan BP, Gomes T, Musselman RP et al.	Trends in colon cancer surgery in Ontario: 2002–2009.	Colorectal Dis 2012;14:e708–12.	Canada	Elective	16998	23.2	2002–2009	[25]
13	Krarup PM, Jorgensen LN, Andreasen AH et al.	A nationwide study on anastomotic leakage after colonic cancer surgery.	Colorectal Dis 2012;14:e661–7.	Denmark		9333	17.3 Range TP: 2.0–41.0	2001–2008	[26]
14	Tanis PJ, Paulino Pereira NR, van Hooft JE et al.	Resection of obstructive left-sided colon cancer at a national level: a prospective analysis of short-term outcomes in 1,816 patients.	Dig Surg 2015;32:317–24.	Netherlands	Emergency	1485	9.2	2009–2012	[27]
15	Hansen DG, Fox JP, Gross CP et al.	Hospital readmissions and emergency department visits following laparoscopic and open colon resection for cancer.	Dis Colon Rectum 2013;56:1053–61.	USA	Elective	6760	49.0	2008–2009	[28]
16	Dobbins TA, Young JM, Solomon MJ.	Uptake and outcomes of laparoscopically assisted resection for colon and rectal cancer in Australia: a population-based study.	Dis Colon Rectum 2014;57:415–22.	Australia	Elective + Emergency	20977	6.1 Range TP: 1.5–20.7 Emergency 0.45	2000–2008	[29]
17	Moghadamyeghaneh Z, Carmichael JC, Mills S et al.	Variations in laparoscopic colectomy ttilization in the United States.	Dis Colon Rectum 2015;58:950–6.	USA	Elective	192063	49.6 Range TP: 45–53.5	2009–2012	[30]
18	Krarup PM, Nordholm-Carstensen A, Jorgensen LN et al.	Association of comorbidity with anastomotic leak, 30-day mortality, and length of stay in elective surgery for colonic cancer: a nationwide cohort study.	Dis Colon Rectum 2015;58:668–76.	Netherlands	Elective	8597	18.7	2001–2008	[31]

(*continued on next page*)

Table 1 (*continued*)

N	Author	Title	Journal	Country	Setting	N of Patients	Rate of Laparoscopic Patients	Years of Investigation	Ref
19	Doumouras AG, Saleh F, Eskicioglu C et al.	Neighborhood variation in the utilization of laparoscopy for the treatment of colon cancer.	Dis Colon Rectum 2016;59:781–8.	Canada	Elective	9969	43.3	2008–2012	[32]
20	SCOAP Collaborative.	Adoption of laparoscopy for elective colorectal resection: a report from the Surgical Care Outcomes Assessment Program.	J Am Coll Surg 2012;214:909–18.	USA	Elective	9705	38.0 Range TP: 23.3–41.6	2005–2010	[33]
21	Sticca RP, Alberts SR, Mahoney MR et al.	Current use and surgical efficacy of laparoscopic colectomy in colon cancer.	J Am Coll Surg 2013;217:56–62.	USA	Elective	3393	37.7	2004–2009	[34]
22	Damle RN, Macomber CW, Flahive JM et al.	Surgeon volume and elective resection for colon cancer: an analysis of outcomes and use of laparoscopy.	J Am Coll Surg 2014;218:1223–30.	USA	Elective	17749	45.0 Range TP: 42–48	2008–2011	[35]
23	Reames BN, Sheetz KH, Waits SA et al.	Geographic variation in use of laparoscopic colectomy for colon cancer.	J Clin Oncol 2014;32:3667–72.	USA	Elective + Emergency	93786	32.5 Range GV: 0–66.8	2009–2010	[36]
24	Park SJ, Lee KY, Lee SH.	Laparoscopic surgery for colorectal cancer in Korea: nationwide data from 2008–2013.	J Minim Invasive Surg 2015;18:39–43.	Korea		112509	55.7 Range TP: 43.4–64.5	2008–2013	[37]
25	Yeo H, Niland J, Milne D et al.	Incidence of minimally invasive colorectal cancer surgery at National Comprehensive Cancer Network centers.	J Natl Cancer Inst 2015;107:362.	USA	Elective	2493	36.0 Range TP: 35–51	2005–2010	[38]
26	Gruber K, Soliman AS, Schmid K et al.	Disparities in the utilization of laparoscopic surgery for colon cancer in rural Nebraska: a call for placement and training of rural general surgeons.	J Rural Health 2015;31:392–400.	USA	Elective + Emergency	1062	28.0 Emergency 10.2	2008–2011	[39]
27	Henneman D, Ten Berge MG, Snijders HS et al.	Safety of elective colorectal cancer surgery: non-surgical complications and colectomies are targets for quality improvement.	J Surg Oncol 2014;109:567–73.	Netherlands	Elective	10184	53.0	2011–2013	[40]
28	Sammour T, Jones IT, Gibbs P et al.	Comparing oncological outcomes of laparoscopic versus open surgery for colon cancer: analysis of a large prospective clinical database.	J Surg Oncol 2015;111:891–8.	Australia	Elective	1106	50.6 Range TP: 7–67	2003–2009	[41]
	Babaei M, Balavarca Y, Jansen L et al.	Minimally invasive colorectal cancer surgery in Europe: implementation and outcomes.	Medicine (Baltimore) 2016;95:e3812. NNCR (Population-based registry)	Netherlands	Elective	58927	39.0	2009–2014	[42]
			Medicine (Baltimore) 2016;95:e3812.SCRCR (Population-based registry)	Sweden	Elective	35690	7.0	2007–2014	
]29			Medicine (Baltimore) 2016;95:e3812. NCR (Population-based registry)	Norway	Elective	15078	23.0	2007–2012	
30	Turagava J, Sammour T, Al-Herz F et al.[a]	Short-term outcomes of laparoscopic resection for colon cancer in a provincial New Zealand hospital.	N Z Med J 2012;125:17–26.	New Zealand	Elective	536	25.7	2001–2010	[43]
31	Lim SB, Choi HS, Jeong SY et al.	Feasibility of laparoscopic techniques as the surgical approach of choice for primary colorectal cancer: an analysis of 570 consecutive cases.	Surg Endosc 2008;22:2588–95.	Korea		2820	20.1 Range TP: 2.4–66.1	2000–2006	[44]
32	Kemp JA, Finlayson SR.	Nationwide trends in laparoscopic colectomy from 2000 to 2004.	Surg Endosc 2008;22:1181–7.	USA	Elective	301229	Range TP: 1.4–4.3	2000–2004	[45]
33	Stefanou AJ, Reickert CA, Velanovich V et al.	Laparoscopic colectomy significantly decreases length of stay compared with open operation.	Surg Endosc 2012;**26**:144–8.	USA	Elective + Emergency	45654	27.3 Emergency 3.6	2005–2009	[46]
34	Alnasser M, Schneider EB, Gearhart SL et al.	National disparities in laparoscopic colorectal procedures for colon cancer.	Surg Endosc 2014;28:49–57.	USA	Elective + Emergency	14502	32.3	2009	[47]
35	Stormark K, Søreide K, Søreide JA et al.	Nationwide implementation of laparoscopic surgery for colon cancer: short-term outcomes and long-term survival in a population-based cohort.	Surg Endosc 2016;30:4853–4864.	Norway	Elective + Emergency	8707	27.1 Range TP: 16–36 Emergency 6.1	2007–2010	[48]
36	Askari A, Nachiappan S, Currie A et al.	Selection for laparoscopic resection confers a survival benefit in colorectal cancer surgery in England.	Surg Endosc 2016;30:3839–47.	UK		141682	20.9 Range TP: 0.4–48	2001–2011	[9]

37	Saia M, Buja A, Mantoan D et al.	Colon Cancer Surgery: a retrospective study based on a large administrative database.	Surg Laparosc Endosc Percutan Tech 2016;26:e126–e131.	Italy	Elective + Emergency	14085	29.0 Range TP: 23.8–36.0 Emergency 12.0	2008–2013	[10]
38	Olsen F, Uleberg B, Jacobsen BK et al.	Norwegian patients with colon cancer start their adjuvant therapy too late.	Tidsskr Nor Laegeforen 2016;136:27–31.	Norway		1132	27.9	2008–2013	[49]
39	Cummings LC, Delaney CP, Cooper GS.	Laparoscopic versus open colectomy for colon cancer in an older population: a cohort study.	World J Surg Oncol 2012;10:31.	USA	Elective + Emergency	27436	1.5 Emergency 0.04	1996–2002	[50]
40	D'Angela D, Glorioso V, Cambiano C et al.	PariSanità, Rapporto 2017	Centro Studi Assobiomedica, Maggio 2017	Italy		38109	30.9	2014	[51]
41	Braun M, Hill J, Kuryba A et al.	An audit of the care received by people with bowel cancer in England and Wales 2016 annual report.	www.digital.nhs.uk	UK	Elective + Emergency	18773	52.3 Emergency 3.2	2014–2015	[52]
42	Frasson M, Flor-Lorente B, Rodríguez JL et al.	Risk factors for anastomotic leak after colon resection for cancer: multivariate analysis and nomogram from a multicentric, prospective, national study with 3193 patients.	Ann Surg 2015;262:321–30.	Spain	Elective + Emergency	3193	35.6	2011–2012	[53]

TP: time period; GV: geographic variation.
[a] Institute-based registry, only Hospital in the region).

(median 14790.0, SD 227888.7, range: 95.0–1314696.0) from 1996 to 2014. Four continents were represented, however, a prevalence of studies from the USA was reported (18 out of 44 investigations, 40.9%). Among the European countries, the Netherlands reported the vast majority of studies, followed by UK. Despite this, the actual rate of MIS in the vast majority of European countries still needs further investigation. Similarly, evidence was lacking in Asiatic studies with the exception of Korea.

All studies were based on multiple-institutions (registries/population-based studies) with the sole exception of New Zealand; the study by Turagava and co-authors was included nevertheless, however, since they reported the results of the only hospital of the region [43].

Of note, we extrapolated the rate of MIS colectomies in each study and presented the result as representative of the country, although few studies were based exclusively on registry of a determined region/province. Whenever possible, however, we highlighted difference in geographic variations, Table 1.

The overall mean rate of MIS procedures was 28.4% (median 27.6, SD 15.9, range 1.5–55.7%), including elective and emergency resections. The vast majority of studies were indeed focused on elective resections, reporting a mean rate of laparoscopic procedures of 32.4%. As expected, when data regarding emergency procedures were extrapolated [10,14,19,21,23,27,29,36,39,46–48,50] the rate of MIS reported was extremely low: mean value 6.5% (median 7.0%), T test elective *vs* emergency p value 0.00004.

Fig. 2 shows the rate of MIS in different countries and different studies over the years. We could provide a time variation for all the countries investigated, with the sole exception of Spain, Sweden and New-Zealand [42,43,53]. As documented in the Figure, we could observe the rate of MIS increased over the years in all countries. However, in Europe is currently still sub-optimal since it ranges 20.0–35.6 Italy [10,51], Spain and Norway [42,48,49,53]. Opposite, this rate is significantly lower in Sweden – about 7.0% [42] - and higher in the Netherlands – (53.0%) and in the UK [40,52].

Colon cancer MIS and society guidelines

Table 2 shows the results of the bibliographic search through scientific society guidelines. We retrieved 13 guidelines focused on colorectal cancer treatment representing all the continents [54–66], documenting also from this analysis a prevalence of American reports (30.7%), consistently with the language selection criteria adopted for this search. Although two guidelines were uninformative regarding MIS and recommendation for clinical practice [55,56], the vast majority of scientific societies recommend the use of laparoscopic resection for colon cancer based on the surgeon's documented experience as well as on patient- and tumor-specific factors. Indeed, the main concern of scientific group were: surgeon's training, transverse tumor and resection of metastatic disease/bulky tumor if a curative resection can be achieved using open approach. Other concerns were related to laparoscopic staging of liver metastases, obese patients and the difficulties of a D3 dissection.

Delphi results and consensus statements

Adhesion rate for Round 1 was of 91.2%, for Round 2 was of 91.1% and finally in Round 3 – Round 4 was of 88.2%. Table 3 shows the roadmap of the experts invited to join the Delphi. These data were collected at the beginning of Round 1 and, although few collaborators did not disclose their demographic data at that stage, we could provide a significant representation of the panel composition. The mean age of the surgeons was about 50.0 years affiliated to University Hospitals in more than a half of the cases; interestingly, the totality of the experts were males. All European zones were

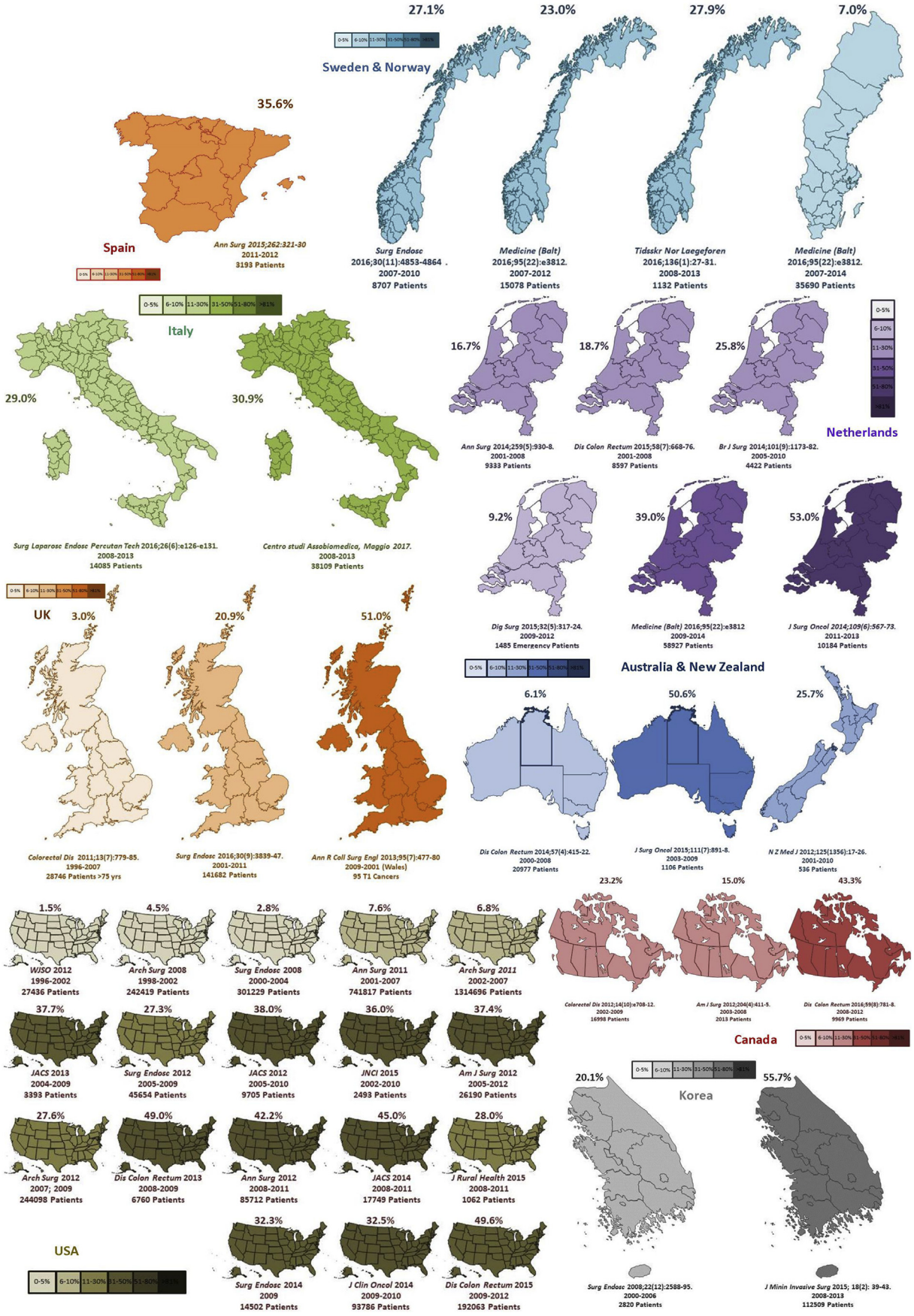

Fig. 2. Rates of MIS procedures for colon cancers in different countries over the years.

Table 2
Scientific Societies Guidelines for the surgical treatment of colon cancer.

N	Society	Year	Reference	Country	MIS recommendation	Ref
1	ASCRS	2012	Chang GJ, Kaiser AM, Mills S et al. Practice parameters for the management of colon cancer. Dis Colon Rectum 2012; 55: 831–843.	USA	Laparoscopic and open colectomy achieve equivalent oncological outcomes for localized colon cancer. The use of the laparoscopic approach should be based on the surgeon's documented experience in laparoscopic surgery as well as on patient- and tumor-specific factors. Grade of Recommendation: 1A.	[54]
2	EAST	2016	Ferrada P, Patel MB, Poylin V et al. Surgery or stenting for colonic obstruction: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg 2016, 80: 659–664.	USA	n/a	[55]
3	ECCO	2017	Beets G, Sebag-Montefiore D, Andritsch A et al. ECCO Essential Requirements for Quality Cancer Care: Colorectal Cancer. A critical review. Crit Rev Oncol Hematol 2017; 110: 81–93.	Europe	n/a	[56]
4	ERAS	2012	Gustafsson UO, Scott MJ, Schwenk W et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS) Society recommendations. Clinical Nutrition 2012; 31:783–800.	America/Europe /UK/ New Zealand	Summary and recommendation: Laparoscopic surgery for colonic resections is recommended if the expertise is available. Evidence level: Oncology: High. Morbidity: Low (inconsistency). Recovery/LOSH: Moderate (inconsistency) Recommendation grade: Strong	[57]
5	ESMO	2013	Labianca R, Nordlinger, Beretta GD et al. Early colon cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol 2013; 24(Supplement 6): vi64–vi72.	Europe	Laparoscopic approach has now received wide acceptance for several types of surgical procedures of major abdominal surgery. Laparoscopic colectomy can be safely carried out for colon cancer, particularly for left-sided cancer [I]. For right-sided colonic cancers, the benefit is less obvious since anastomosis must be hand sewn, which requires a laparotomy [IV]. The long-term oncological results of laparoscopic colectomy are similar to those of the conventional approach [I]. Advantages of laparoscopy over the conventional approach are reduced pain, reduced length of hospital stay and reduced duration of ileus [II]. It is recognised that a laparoscopic approach should only be carried out if the following criteria are met: (i) technically experienced surgeons, (ii) lack of serious abdominal adhesion due to prior major abdominal surgery, (iii) no locally advanced disease and/or acute bowel obstruction or perforation.	[58]
6	EURECCA	2014	van de Velde CJH, Boelens PG, Borras JM et al. EURECCA colorectal: Multidisciplinary management: European consensus conference colon & rectum. Eur J Cancer 2014; 50: 1.e1– 1.e34.	Europe	Laparoscopic colon cancer surgery results in several benefits in the direct postoperative period in comparison to open colonic surgery. Laparoscopic surgery for colon cancer is safe and as effective as open surgery. Given the prolonged learning curve associated with laparoscopic surgery, it is very important that the surgeon is adequately trained before practising this technique on his or her own. Laparoscopic resection has some disadvantages such as a long learning curve, longer duration of operation and higher operative costs. Restrictions in laparoscopic technique are related to previous abdominal surgery (adhesions), and to locally advanced disease (relative contraindication). With minimal consensus, it was agreed that the indication for laparoscopic surgery is not stage dependent and that even combined laparoscopic segmental colon resection and liver metastasectomy can be safely performed in stage IV in expert centers.	[59]
7	EAES	2012	Agresta F, Ansaloni A, Baiocchi GL et al. Laparoscopic approach to acute abdomen from the Consensus Development Conference of the Società Italiana di Chirurgia Endoscopica e nuove tecnologie (SICE), Associazione Chirurghi Ospedalieri Italiani (ACOI), Società Italiana di Chirurgia (SIC), Società Italiana di Chirurgia d'Urgenza e del Trauma (SICUT), Società Italiana di Chirurgia nell'Ospedalità Privata (SICOP), and the European Association for Endoscopic Surgery (EAES). Surg Endosc 2012; 26:2134–64.	Italy	n/a	[60]
8	HeSMO	2016	Xynosa E, Gouvasb N, Triantopoulouc C et al. Clinical practice guidelines for the surgical management of colon cancer: a consensus statement of the Hellenic and Cypriot Colorectal Cancer Study Group by the HeSMO. Ann Gastroenterol 2016; 29: 3–17.	Greece	Laparoscopic surgery for uncomplicated cancer of the right and left colon offers faster recovery and less morbidity as compared to the open approach. Oncological results are similar between the two approaches, provided that the surgical team involved is well trained and serves a large volume of cases (LOE I, SOR A) (ROVC: 96%) Laparoscopic resection of tumors of the transverse colon may be technically demanding and the quality of specimen may not be optimal	[61]

(*continued on next page*)

Table 2 (*continued*)

N	Society	Year	Reference	Country	MIS recommendation	Ref
					due to difficult dissection, ligation and division of the middle colic vessels at their origin (LOE III, SOR A) (ROVC: 93%) Laparoscopic approach is not indicated for bulky and advanced colon lesions, where curative resection can be achieved by open surgery (LOE I, SOR A) (ROVC: 94.5%) Small lesions not visible by laparoscopy should be marked prior to surgery (LOE III, SOR A) (ROVC: 99%) As conversion may be associated with increased morbidity as compared both to laparoscopically completed and to open approach, predictive factors for conversion, such as obesity or ASA III–IV cases, should be identified prior to laparoscopy (LOE II, SOR B) (ROVC: 92%) Early or pre-emptive as opposed to late conversion does not seem to be associated with increased morbidity (LOE IV, SOR B) (ROVC: 89%)	
9	HeSMO (Stage IV Colon Cancer)	2016	Dervenisa C, Xynosb E, Sotiropoulosc G et al. Clinical practice guidelines for the management of metastatic colorectal cancer: a consensus statement of the Hellenic Society of Medical Oncologists (HeSMO). Ann Gastroenterol 2016; 29: 390–416.	Greece	Laparoscopic staging of liver metastasis with the use of US is of limited accuracy (LOE I, SOR A) (ROVC: 84%) Due to lack of high level of evidence, the laparoscopic approach for the resection of hepatic metastases is not recommended, unless performed by a very experienced surgical team and within the context of clinical trials (LOE IV, SOR D) (ROVC: 97%) In selected cases and in experienced centers, a laparoscopic approach can be applied both for the resection of primary and hepatic metastases, either by the one- or two- stage approach	[62]
10	JSCCR	2017	WatanabeT, Muro K, Ajioka Y et al. Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines 2016 for the treatment of colorectal cancer. Int J Clin Oncol 2017; doi 10.1007/s10147-017-1101-6.	Japan	The indications for laparoscopic surgery are determined by considering the surgeon's experience and skills, as well as tumor factors, such as the location and degree of progression of the cancer, and patient factors, such as obesity and history of open abdominal surgery. Clinical Question: is laparoscopic surgery for colorectal cancer effective? • According to randomized controlled trials held overseas and the Cochrane Database of Systematic Reviews, the safety and long-term outcome of laparoscopic surgery in cases of colonic and RS cancers are similar to those in open surgery. As D3 dissection is difficult under laparoscopic conditions, laparoscopic surgery for cStage II–cStage III disease should be implemented when it is considered that the individual surgical team is sufficiently experienced. Laparoscopic surgery is also difficult in patients with transverse colon cancer, in severely obese patients, and in patients with severe adhesions. • The efficacy and safety of laparoscopic surgery for rectal cancer has not been established. Ideally, appropriately planned clinical trials should be implemented. (Recommendation/Evidence level 1B).	[63]
11	NCCN	2017	www.nccn.org	USA	Minimal Invasive Surgery can be considered based on the following criteria: The surgeon has experience in performing laparoscopic assisted colorectal operations. There is no locally advanced disease. It is not indicated for acute bowel cancer obstruction or perforation from cancer. Throughout abdominal exploration is required. Consider preoperative marking of the lesion(s).	[64]
12	SAGES	2012	www.sages.org	USA	One of the most controversial issues in minimally invasive surgery has been the implementation of laparoscopic techniques for resection of curable colorectal malignancies. Initial concerns included the potential violation of oncologic principles, the effects of carbon dioxide insufflation, and the phenomenon of port site tumor recurrence. Basic science research and large randomized controlled trials are now demonstrating that these fears were unjustified. The laparoscopic approach, however, involves a steep learning curve and requires the surgeon and ancillary operating room staff to have advanced skills in laparoscopy. When approaching colon resection laparoscopically, every effort should be made to localize the tumor preoperatively. Small lesions should be marked endoscopically with permanent tattoos before surgery to maximize the surgeon's ability to identify the lesion. Surgeons should be prepared to use colonoscopy intraoperatively if lesion localization is uncertain. (++OO, strong) We recommend that laparoscopic resection follow standard oncologic principles: proximal ligation of the primary arterial supply to the segment harboring the cancer, appropriate proximal and distal margins, and adequate lymphadenectomy. (++++, strong) For locally advanced adherent colon and rectal tumors, an en bloc resection is recommended. We suggest an open approach if a	[65]

Table 2 (*continued*)

N	Society	Year	Reference	Country	MIS recommendation	Ref
					laparoscopic en bloc resection cannot be performed adequately. (++OO, weak) We recommend that patients with an obstructing right or transverse colon cancer undergo a right or extended right colectomy. The open approach is required if the laparoscopic approach will not result in an oncologically sound resection. (++OO, strong) We suggest that for patients with an obstructing left-sided colon cancer, the procedure be individualized according to clinical factors. Colonic stenting may increase the likelihood of completing a one-stage procedure and may decrease the likelihood of an end colostomy. (+++O, weak) Before surgeons apply the laparoscopic approach for the resection of curable colon and rectal cancer, they must have adequate knowledge, training, and experience in laparoscopic techniques and oncologic principles. (+++O, strong)	
13	SIGN	2016	Scottish Intercollegiate Guidelines Network (SIGN). Diagnosis and management of colorectal cancer. Edinburgh: SIGN; 2011. (SIGN publication no. 126). [December 2011]. Available from URL: http://www.sign.ac.uk	Scotland	Laparoscopic and open surgery can be offered for resection of colorectal cancer.	[66]

Table 3
Delphi study and panel composition – the roadmap.

Age		
Mean; SD	49.5	7.9
Median	50.0	
SD	7.8	
Range	37.0	65.0
Eurozone (Eurovoc Regions)	n	%
Southern Europe	8.0	26.7
Western Europe	13.0	43.3
Eastern Europe	6.0	20.0
Northern Europe	2.0	6.7
Other (USA)	1.0	3.3
Total	30.0	100.0
Institution	n	%
University	16.0	55.2
Community	9.0	31.0
Private	2.0	6.9
Other	2.0	6.9
Total	29.0	100.0
Training in Colorectal Cancer	n	%
Yes	26.0	86.7
No	4.0	13.3
Total	30.0	100.0
Years of Practice in Colorectal Cancer	n	%
<5 yrs	0.0	0.0
Range 6-10	8.0	26.7
>10	22.0	73.3
Total	30.0	100.0
Hospital Colorectal Cancer Volume	n	%
<30	0.0	0.0
Range 31–50	3.0	10.3
Range 51–100	6.0	20.7
>101	20.0	69.0
Total Fill	29.0	100.0
Personal Rate of Laparoscopic Colorectal Cancer	n	%
<30	2.0	6.9
Range 31–50	1.0	3.4
Range 51–80	4.0	13.8
>80	22.0	75.9
Total	29.0	100.0
Other Colorectal Cancer Surgeons at Institution	n	%
0	0.0	0.0
1	8.0	27.6
>2	21.0	72.4
Total	29.0	100.0
Conversion Rate		
Mean; SD	6.5	5.4
Median	5.0	
Range	0.0	25.0

represented and about 87% of the panel was specifically trained in colorectal surgery, with more than 10 years in colorectal cancer care (73.3%). Most importantly, the vast majority of surgeons came from high volume institutions, had a significant rate of laparoscopic procedure/year and a minimal conversion rate. Most importantly, the greater percentages of their affiliation met the most recent ECCO recommendations regarding the minimum number of surgeons to be involved in colorectal cancer care (>2 surgeons) [56].

On the other hand, Table 4 shows the consensus statements that we could provide in a series of four rounds. In line with this paper aim, experts agreed in a common definition of laparoscopic colectomy as "*a colon resection performed using key-hole surgery independently from the type of anastomosis*"; opposite it was agreed that all other "*hand-assisted procedures or resections characterized by few laparoscopic maneuvers followed by open resection should not be marked as laparoscopic colectomies*".

A consensus was reached also for the definition of conversion surgery as "*an un-planned interruption of laparoscopic maneuvers that requires a laparotomy*" although almost the totality supported the idea that an external anastomoses is not a criterion for defining conversion.

In order to perform a laparoscopic colectomy which requires a number of devices; the experts rated few items and agreed that the advanced energy device, a 30° scope and the wound retractor/protector could be assessed, in their experience, as essential.

Similarly, we consulted the panel regarding the principles of surgical oncology, and a consensus was reached for a central/high ligation of the vascular pedicles and a complete mesocolon excision for late stages tumors (i.e. $\geq$ cT3N+); finally, the totality of the experts agreed that it should be respected the embryologically planes to create an intact envelope containing all the nodes. In relation to the surgical procedure, it was agreed that reports should be check-listed and should include a number of items as the exact tumor location, vessel ligation, integrity of the mesocolon in order to standardize and homogenize also the reporting of the procedure.

We also briefly discussed evidences in relation to possible advantages or pitfalls, and as expected, the experts recognized the results of RCTs in relation to the short-term functional benefits and the non-inferiority of long term oncological results. Most importantly, given the following definitions: a) best practice - a technique that has been accepted as superior because it produces improved results comparing to those achieved by other means and b) guidelines - statements generated by the evidences aimed to guide decisions and criteria regarding diagnosis, management, and

Table 4
Consensus statements from Delphi study.

	Statement	Consensus	Round
Statement A: Definition of Laparoscopic Colectomy			
	Laparoscopic colectomy is a colon resection performed using key-hole surgery independently from the type of anastomosis	**Range 6–7** 80.0%, Mean 6.2, Median 7.0, Mode 7.0, CV<0.5, IQR 0.8	Round 1
Opposite	All other hand-assisted procedures or resections characterized by few laparoscopic maneuvers followed by open resection should not be marked as laparoscopic colectomies	**Range 6–7** 93.3%, Mean 6.5, Median 7.0, Mode 7.0, CV 0.2, IQR 0.8	Round 2
Statement B: Definition of Conversion Surgery			
	A un-planned interruption of laparoscopic maneuvers that requires a laparotomy	93.5%[a]	Round 1
Opposite	An extra-corporeal anastomosis is not a criterion for defining conversion surgery	93.3%[a]	Round 2
Statement C: Conversion			
	Patients intolerance to pneumo-peritoneum is a scenario that requires conversion	80.0%[a]	Round 1
Statement D: Technical Requirements			
	A laparoscopic colectomy for colon cancer is a surgical procedure which requires a number of devices. Experts community rated few items and agreed that the following could be assessed, in their experience, as essential		
	Advanced energy device	**Range 6–7** 77.4%, Mean 6.4, Median 7.0, Mode 7.0, CV 0.2 IQR 1.0	Round 1
	30° scope	**Range 6–7** 76.7%, Mean 5.8, Median 6.0, Mode 7.0, CV 0.3, IQR 1.0	Round 2
	Wound protector/retractor	**Range 6–7** 90.0%, Mean 6.6, Median 7.0, Mode 7.0, CV 0.1, IQR 0.8	Round 2
Statement E: Oncological Requirements			
	Laparoscopic procedures for colon cancer should aim to a complete removal of the tumor and of the nodes draining the pedicles, providing an adequate nodal harvest in accordance with standard and validated principles of surgical oncology; these include		
	A central vessel ligation for right colon cancer	**Range 6–7** 83.9%, Mean 6.5, Median 7.0. Mode 7.0, CV 0.25, IQR 0.0	Round 1
	A high colon ligation for left colon cancer	**Range 6–7** 76.7%, Mean 6.0, Median 7.0. Mode 7.0, CV 0.3, IQR 1.0	Round 1
Furthermore	Complete Mesocolic Excision is essential in Late Stages Colon Cancers	**Range 6–7** 90.0%, Mean 6.5, Median 7.0, Mode 7.0, CV 0.2, IQR 0.0	Round 2
	Nodal dissection for colon cancer should be performed according to "the embryologically defined mesocolic planes to create an intact envelope of the mesocolic fascia, and all lymph nodes along the tumour supplying vessels should be contained in the specimen" (*Lancet Oncol* 2015; **16**: 161–68)	**Range 6–7** 100.0% Mean 6.9, Median 7.0, Mode 7.0, CV 0.0, IQR 0.0	Round 4
Statement F: Surgical Reports			
	Surgical reports should be standardized and, along with a brief description of the procedure, should include a checklist for		
	Intra-operative tumor location	100.0%[a]	Round 2
	Infiltration of other organs	100.0%[a]	Round 2
	Level of vessel ligations	100.0%[a]	Round 2
	Integrity del mesocolon	86.7%[a]	Round 2
	Presence of carcinosis	96.4%[a]	Round 3
	Type of anastomosis	96.4%[a]	Round 3
Statement G: MIS and EBM			
	Currently, randomized controlled trials provide level I evidence supporting a better and shorter postoperative recovery with respect to open surgery for treatment of colon cancer – In Right-Sided Colon Cancer	**Range 6–7** 85.7% Mean 6.4, Median 6.5, Mode 7.0, CV 0.1, IQR 1.0	Round 2
	Currently, randomized controlled trials provide level I evidence supporting a better and shorter postoperative recovery with respect to open surgery for treatment of colon cancer – In Left-Sided Colon Cancer	**Range 6–7** 100.0% Mean 6.6, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 2
	Currently, randomized controlled trials document equal long-term survival outcomes with respect to open surgery for treatment of colon cancer – In Right-Sided Colon Cancer	**Range 6–7** 83.3% Mean 6.7, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 2
	Currently, randomized controlled trials document equal long-term survival outcomes with respect to open surgery for treatment of colon cancer – In Left-Sided Colon Cancer	**Range 6–7** 80.0% Mean 6.3, Median 7.0, Mode 7.0, CV 0.2, IQR 1.0	Round 2
	When performed by surgeons experienced in mini-invasive surgery laparoscopic right colectomy for cancer can be marked as "best practice" in guidelines, should the standard principles of surgical oncology be respected (R0 procedure, vessel ligation and integrity of the mesocolon)	80.8%[a]	Round 3
	When performed by surgeons experienced in mini-invasive surgery laparoscopic left colectomy for cancer can be marked as "best practice" in guidelines, should the standard principles of surgical oncology be respected (R0 procedure, vessel ligation and integrity of the mesocolon)	81.5%[a]	Round 3
Statement H: MIS Integrated in the Care of Colon Cancer Patients			
	The combination of laparoscopy plus enhanced/fast recovery protocols (including but not limited to integral application of ERAS) results in better post-operative outcomes comparing open surgery plus the application of the same protocols	**Range 6–7** 80.0% Mean 6.2, Median 7.0, Mode 7.0, CV 0.2, IQR 1.0	Round 2
	Clinical studies investigating mini-invasive surgery with respect to the technique employed and aiming to evaluate the costs should also measure the "true value" of the procedure. In surgical oncology this outcome should not refer exclusively to the hospital costs but should refer to a more articulated notion including functional recovery, patients reported outcomes and quality of life	**Range 6–7** 90.0% Mean 6.6, Median 7.0, Mode 7.0, CV 0.2, IQR 0.0	Round 2
Statement I: MIS and Training			
	Training in laparoscopic colectomy should be performed exclusively after the fulfill of a basic laparoscopy course (fundamentals would include knowledge of the equipment and devices and achievement of basic skills – dissection, cutting, coagulation, and stitching - in minor procedures i.e. lap appendectomy or cholecystectomy	**Range 6–7** 93.3% Mean 6.0, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 2

Table 4 (*continued*)

	Statement	Consensus	Round
	Training in laparoscopic colectomy should be coded as a step-by-step procedure which should include precise "work packages" (i.e.: anatomy visualization. organ dissection approach. type of anastomosis ect) and "deliveries" (i.e. vascular ligation, resection, anastomosis etc)	**Range 6–7** 86.7% Mean 6.1, Median 7.0, Mode 7.0, CV 0.2, IQR 1.0	Round 2
	Training in laparoscopic colectomy should be part of the curriculum in surgical residency programs	**Range 6–7** 76.7% Mean 6.4, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 2
	Training in laparoscopic colectomy affects the post-operative complication rate (good training=good results vs bad/no training= worse results)	**Range 6–7** 80.0% Mean 6.0, Median 7.0, Mode 7.0, CV 0.3, IQR 1.0	Round 2
	A successful training in laparoscopy reduces costs related to the procedure and hospitalization by reducing the complication rate	**Range 6-7** 83.3% Mean 6.5, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 2
	The quality of laparoscopic colectomy training should be measured using pathological endpoints i.e lymph node harvest and margins	**Range 6–7** 76.7% Mean 5.7, Median 6.0, Mode 7.0, CV 0.3, IQR 1.0	Round 2
	Training in laparoscopic colectomy for cancer should include attendance to MDTs, basis of diagnosis (indication and contraindications to pre-operative tests), understanding the multi-modal treatment (timing and consequences of neo-adjuvant therapy)	**Range 6–7** 89.7% Mean 6.6, Median 7.0, Mode 7.0, CV 0.1, IQR 0.0	Round 2
Statement L: MIS and Quality Assurance			
	Quality assurance and surgical standards are key elements in order to improve colon cancer patients' outcomes and includes:		
	Hospital Volume	**Range 6–7** 75.9% Mean 6.1, Median 6.0, Mode 7.0, CV 0.2, IQR 1.0	Round 4
	Standardized MIS training	**Range 6–7** 89.3% Mean 6.5, Median 7.0, Mode 7.0, CV 0.1, IQR 1.0	Round 4

[a] Multiple choice questions.

treatment in specific areas of medicine, it was agreed that when performed by surgeons experienced in MIS, laparoscopic colectomy for cancer should be marked as best practice in guidelines, given the principles of oncologic surgery be respected (R0 procedure, vessel ligation and integrity of the mesocolon).

Furthermore, it was documented that laparoscopy is integrated in the care of colon cancer patients, since experts valued the opinion that the combination of MIS and enhanced/fast recovery protocols resulted in better post-operative outcomes comparing open surgery plus the application of the same protocols.

Finally, at the end of Round 1 the panel was solicited to express their opinion regarding a possible topic to incorporate as a final domain of interest: the choices included the technical aspects of surgery (i.e. anastomoses), the benefits and controversies of laparoscopic *vs* open approach, hospital volumes, costs and training in laparoscopic colorectal resections. Notably, 96.7% of the responders selected the training as a possible domain. Accordingly, the latter was included in the study.

With this domain, the experts outlined a path of that should be performed exclusively after the fulfill of a basic laparoscopy course, it should be coded as a step-by-step procedure and should be part of the curriculum in surgical residency programs. Indeed the panel agreed that a good training in laparoscopic colectomy has a positive impact on the post-operative complication rate, reduces costs related to the procedure and hospitalization. Nevertheless also the training could be measured i.e. using pathological outcomes and should include the multi-modal cancer treatment.

Round 4 was implemented to have a statement focused on quality assurance: in this field experts recognized the hospital volume and a standardized training as two warrantors of quality in surgical care.

Finally, at the end of each round the experts were asked to rate the questionnaires and the rate of answer ranging 6–7 responses (totally like) increased from 69.2% (mean 5.8, median 6.0, SD 0.8) the end of Round 1–86.2% (mean 6.1, median 6.0, SD 1.1) at the end of Round 3, documenting a positive feedback on how the comments from the panel were received and integrated in the study.

Discussion

Despite the results of RCTs in relation to the benefits of MIS, the rate of laparoscopic colectomies for cancer is still sub-optimal in a number of countries, or conversely is not reported or investigated in the vast majority of the Eurozone.

Although it is very difficult to assess what is the optimal rate of laparoscopic resections for colon cancer we should achieve, we aim this paper to increase awareness on this topic, possibly to spread the statements resulted by the expert consensus in order to increase the adoption of MIS in Europe and anywhere else.

Undoubtedly, literature could provide a sufficient amount of evidences in relation to the short-term outcomes and they are acknowledges by the vast majority of the society guidelines, however, the impact of these results in clinical practice as the rate of MIS procedure for colon cancer performed is an emerging problem. On this basis, randomized controlled trials on laparoscopic surgery were excluded from the systematic review, because they include MIS procedures according to the study design but do not reflect daily situation. Accordingly, and in order to avoid biases from super-specialized centers, we focused on registries and population based studies, aiming firstly to highlight the disparities in geographic variations of results, independently from age, industry support or hospital quality (due to very heterogeneous literature impairing this type of analyses). Nevertheless, few of the studies mirrored the economic status or the health care system (rural areas) analyzed [39].

However, since "English" language was a mesh term in all the systematic review searches, few data could have been missed, as for example, results from large multi-institutional Spanish datasets [67]. On the same extent, we did not examined the quality or did not have a critical assessment of retrieved publications.

There are a number of reasons to explain the low rate of MIS procedures: the first one is the long training required to achieve a standard. With the Delphi study, the panel discussed and highlighted the key facts that belong to the MIS training and that it should be included in the core curriculum of the residency, but also that a good MIS training worth the results in term of reduced complications and hospitalization. Agreement rates and consensus were defined at the beginning of each round (Supplement File 3) as previously described [13,68]; a number of items were also discussed in relation to this domain, but failed to reach consensus, among the others: the use of simulators or animal model and the centralization of training in high volume centers (data not shown). On the other hand, the necessity to have an accreditation in MIS is

topic of interest since 72.6% of the experts rated 6–7 on the Liker scale the following statement: *"training in laparoscopic colectomy should be certified after a) the completion of a core curriculum with a minimum number of procedures performed under supervised mentorship and b) an examination testing knowledge in the various aspect of patient care (i.e. pathology. presentation and diagnosis, treatment and communication)"*. Over the Rounds different topics were highly debated among the experts, as for example CME or the approach to lymphadenectomy: it was agreed that CME should be mandatory exclusively in late stages (i.e. ≥T3N+), although the clinical stage of a colon cancer is sometimes difficult to assess; moreover, as far as it concerns nodal dissection, it took the 4th Rounds to converge on the definition that it should be performed according to "the embryologically defined mesocolic planes to create an intact envelope of the mesocolic fascia, and all lymph nodes along the tumor supplying vessels should be contained in the specimen" as defined by Bertelsen and associates [69].

Another issue is the sustainability: however "costs" were selected as a topic of interests during Round 1 just by 9 experts and on the other hand the panel agreed with a broad consensus that nowadays "*clinical studies investigating MIS with respect to the technique employed and aiming to evaluate the costs should also measure the "true value" of the procedure. In surgical oncology this outcome should not refer exclusively to the hospital costs but should refer to a more articulated notion including functional recovery, patients reported outcomes and quality of life"*.

Undoubtedly, laparoscopic colectomy is a surgical procedures that requires a number of devices, but interestingly the experts converged just on 3 and the most expensive ones (as HD video laparoscopy or an integrated laparoscopic integrated room) failed in reaching a consensus.

As a secondary aim, we herein provide a Position Paper on MIS for colon cancer: a document providing a definition, a description of the technical aspects and of the advantages and pitfalls of a particular procedure or tool. Although we sometimes discussed evidences in relation to possible advantages, the aim of this document was not to discuss what the evidences are, but how those are received and are integrated in the clinical practice by a cohort of leaders in this field from different European countries.

Our findings resulted in 10 consensus statements which summarize the opinion of experts in MIS encompassing 10 different "domains".

This manuscript is one of the firsts to clearly present an insight into the situation in Europe and beyond with regard to laparoscopic colon surgery. Moreover, to the best of our knowledge, this is the first report to provide a clear definition of MIS colectomy for colon cancer, when to perform, what is conversion and what are the minimal essential requirements (from a technical and oncological point of view), since all these items are often not univocal in literature.

MIS was defined as "a *technique that has been accepted as superior because it produces improved results comparing to those achieved by other means*" for right and left colon cancers and experts agreed that MIS should be defined as best practice in surgical oncology guidelines, if the surgeon is experienced and if the principles of surgical oncology are respected.

Conclusion

The rate of MIS colectomies for cancer in Europe in underreported and it should be further investigated. Using Delphi methodology, a panel of leaders in this field defined laparoscopic colectomy ad a best practice procedure when performed by an experienced surgeon respecting the standards of surgical oncology.

Conflict of interest statement

MGR: Colorectal Robotic Surgery Proctor for Intuitive Surgical since 2013. Advisory Board Member of Intuitive Surgical and Medtronics; IM: Instructor for minimally invasive and taTME courses with Olympus Europe SE &co. KG for the years 2016–2017.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ejso.2018.01.091.

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